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First Quarterly Circular for 1940.

RUBBER RESEARCH SCHEME · CEYLON ·

March, 1940.

Rubber Research Scheme (Ceylon)

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The *second* and *fourth* Wednesdays in each month have been set aside as Visitors' Days at Dartonfield estate, and the services of technical officers will be available to visitors on those days. The estate superintendent will be available every Wednesday. Visitors are requested to arrive on the estate not later than 9.30 a.m.

While visitors will be welcomed at the Station on other days, any particular member of the staff may not be free to give them attention unless an appointment has been made.

Dartonfield estate is situated about 3½ miles from the main Matugama-Agalawatta Road, the turn-off being near culvert No. 14/10. The distance from Colombo is approximately 47 miles.

PUBLICATIONS

Rubber Research Scheme publications comprising Annual Reports, Quarterly Circulars and occasional Bulletins and Leaflets are available without charge to the Proprietors (resident in Ceylon) Superintendents and Local Agents of Rubber estates in Ceylon over 10 acres in extent. Application for registration should be made to the Director, stating the name, acreage, and registered number of the estate(s) concerned.

MEMORANDA ON PLANTING TOPICS

Typescript copies of the following memoranda may be obtained on application :—

1—Notes on budgrafting procedure (Revised March, 1940).

2—Programme of manuring for replanted Rubber clearings (Revised June, 1939).

3—Notes on Rubber seedling nurseries (Revised November, 1939).

4—Contour lining, holing and filling, cutting of platforms, trenches and drains (Revised June, 1939).

5—Straining box for latex (March, 1939).

6—Notes on the care of budded trees of clone Tjirandji 1 with special reference to wind damage (September, 1938).

7—Dartonfield Estate. Notes on factory procedure and equipment (Revised November, 1939).

8—Planting and after-care of budded stumps (May, 1939).

9—Preparation of latex for shipment (Revised August, 1939).

10—Root disease in replanted areas (August, 1939).

11—Emergency Rubber coagulants (December, 1939).

12—Warm air drying house for crepe rubber (January, 1940).

13—Notes on the preparation of clean rubber (January, 1940).

CEYLON CLONES VIII (1939)

C. E. FORD, *Geneticist*

Foreword

THIS article continues the series of annual reports on the test tapping of Ceylon clones at the Rubber Research Scheme's Experiment Station, Nivitigalakele, and on Stennes and Millakande Estates. Previous reports of this series were published as follows :—

Ceylon Clones	I	R.R.S. Quarterly Circular,	Vol. 10, Part 2, 1933
Do.	II	do.	Vol. 11, Part 1, 1934
Do.	III	do.	Vol. 12, Parts 1 and 2, 1935
Do.	IV	do.	Vol. 13, Parts 2 and 3, 1936
Do.	V	do.	Vol. 14, Parts 1 and 2, 1937
Do.	VI	do.	Vol. 15, Part 2, 1938
Do.	VII	do.	Vol. 16, Part 1, 1939

Acknowledgment is made to those proprietors who have kindly given permission for the publication of the records of clone established from mother trees on their properties.

Presentation of Results and General Notes

The data are presented in five tables of substantially the same form as last year.

Tables I and II give the average yield in grams per tapping for each year the trees have been tapped and the actual yield in lb. per tree during 1939 ; and the calculated yield on the basis of 130 tappings on the half spiral alternate day system, respectively. The criterion applied to clones at Nivitigalakele for inclusion in these two tables was a yield equal to or better than P.B. 25 : The same clones as in previous years have been included from Millakande and Stennes Estates.

It will be noted that several clones show a decrease in yield as compared with 1938, while in others the increase is of a low

order. 1939 was, in general, a poor year for crop, as evidenced by the fact that there was a considerable shortfall on the estimate on both Dartonfield and Nivitigalakele, unfavourable distribution of rainfall being probably the main cause.

Table III was included for the first time in the article published in 1938 and represents an attempt to compare the yields of Ceylon clones with imported clones growing under similar conditions. The comparison is not a rigorous one and cannot be stressed too strongly, nevertheless, it may be concluded that the best Ceylon clones are capable of yields of the same order as those of the best imported clones. A full discussion of this question was included in the 1938 publication just mentioned.

The records from Wawulugala Estate are taken from a mixed polyclone area planted in 1932 and test tapped from November 1938 to October 1939 on the $\frac{1}{2}$ S, a.d. 100% system, except for Glenshiel 1, which was tapped on 1/3 S, a.d. 67%.

Table IV gives the yield in lb. per tree for the year, calculated on a basis of 130 tappings, for all the clones in test tapping at Nivitigalakele. In 1939, test tapping of clones was confined to the five fields of the 1928 clearings and the table is sub-divided into sections corresponding to these fields. Within fields the ordering of clones is first by tapping year and second by yield. A number of clones were tapped in March 1939 for the first time and consequently did not appear in last year's table. On the other hand, several clones included in last year's table are absent this year. These clones had only given poor or moderate yields after three years tapping and were considered not to be worth further test.

Table V presents the 1939 yields of the clones in semi-commercial tapping at Nivitigalakele adjusted on a basis of 130 tappings as in Table IV. In every case the yield given is representative of the full number of trees in tapping; but in clones Millakande 3/2 and Kosgalla 6, where a number of trees are in test tapping, the figure is a composite one derived from both the commercial and the test tapping records.

It is necessary to point out that the comparison between clones in Tables IV and V is not a critical one since there is no replication and some clones are more favourably situated than others. Hence the tables should not be considered as indicative of true order of merit.

Table VI, included this year for the first time, gives bark renewal measurement data of the three highest yielding clones, Millakande 3/2, Wagga 6278, and Hillcroft 28. The measured trees of the latter two clones are all in test tapping, but are representative of the whole stand of original buddings in each case; the measured trees of Millakande 3/2, on the other hand, are taken partly from the trees in commercial tapping (except those measured for six years renewal) and are somewhat above the average of the original buddings in girth.

Tapping.—With the exception of the Hillcroft clones on Stennes Estate, TJ. 1 on Millakande, and Glenshiel 1 on Wawulugala, all clones included in the tables have been tapped throughout their tapping history on the half spiral alternate day system. Yields are in every case recorded only from those trees which were tapped continuously throughout the year to which the figures refer.

Selection of Trees for Test Tapping.—The selected trees of Hillcroft 55 on Stennes and of all clones at Nivitigalakele except Millakande 3/2 constitute random samples of the original grafts. The trees of Hillcroft 28 on Stennes and of all clones on Millakande are probably rather above the average of the block in girth.

Determination of Age.—In all cases the age is determined from the time of budding or planting to the middle of the tapping year.

Seedling Controls at Nivitigalakele.—The 1926, 1927, and 1928 clearings at Nivitigalakele were planted with seed-at-stake or ordinary seedling stumps and the "seedling controls" are plots of these original seedlings which have been left unbudded. In the 1926 clearing and Field 3A of the 1928 clearing, seed from selected mother trees was used, whereas ordinary unselected seed was used in the 1928 clearing Field 4A. Budding was delayed in many cases and so the seedlings have an advantage of from one to three years in age over the buddings.

Notes on Individual Clones

Millakande 3/2.—While most other clones at Nivitigalakele were barely maintaining their yield or even showing a slight regression, the average yield of the ten trees of MK. 3/2 in test tapping increased in 1939 by 40 per cent. to 15.6 lbs. per tree. This satisfactory performance is confirmed by the 33 per cent. increase for

the same period shown by the remaining trees of this block, which are in semi-commercial tapping. Altogether the 66 trees in tapping, test and semi-commercial, gave an average of 10.1 lbs. per tree for the year, or 1,240 lbs. per acre over the measured area of 0.54 acres.

On Millakande Estate the yield has again shown a moderate increase although 1939 was a bad year there also. The lower level of yield on Millakande, in spite of the fact the trees are a year older, is probably due to poorer soil conditions.

At Nivitigalakele the clone is very vigorous. The 51 original buddings, for example, averaged 32.6 inches in girth at three feet from the union in January, 1940, when they were 9½ years old. The supplies have also grown very well and out of a total stand of 70 trees, only two had failed to attain a girth of 18 inches by January, 1938, 7½ years after planting. The trees on Millakande are not so well grown, though still quite robust. Observations on the growth of young buddings in a number of localities confirm that the clone is a vigorous grower.

The reports of Brown Bast from Nivitigalakele are probably not so serious as was at first supposed. To date, eight cases have been recorded, three from the test tapped and five from the commercially tapped trees. Only one tree has been affected seriously, and even that is yielding satisfactorily on the unaffected panel. The remaining seven may have suffered merely from a temporary drying of the cuts, perhaps akin to the condition known to be developed at times by Glenshiel 1 in Malaya; at any rate they have entirely recovered. The trees on Millakande continue to be free from any defect of this kind.

Two cases of uprooting by wind have occurred on Nivitigalakele and none on Millakande.

A minor defect is the late dripping habit, similar to TJ. 1. It is often necessary to use a second cup in order to avoid loss of crop.

The clone has an attractive habit, with a straight trunk free from irregularities and a narrow crown. Its branching habit is fastigiate, somewhat similar to P.B. 25. Virgin bark is rather thin, but renewal is excellent, being both strong and even.

This clone has yielded so well on Nivitigalakele and Millakande and, moreover, is so free from serious defects that its use

for planting on a large scale may now be recommended for areas of similar soil in the wet districts. In the drier districts it is suggested that, for the present, its use should be confined to a small scale (not more than 10% of a planting programme).

Millakande 1/1.—This clone continues to be disappointing after its good early yields. At Nivitigalakele the yield is actually less than it was two years ago while at Millakande it has barely been maintained.

Millakande 4/3.—The yield of this clone has declined since 1937 and is now barely sufficient to warrant its inclusion in this report.

Hillcroft 28.—The original buddings on Stennes Estate were tapped throughout 1936 and 1937 on ½ S, a.d. 67% on account of the incidence of Brown Bast. This system was evidently not suited to the clone, since not only was there a reduction in total yield per tree for the year, but yield per tapping also decreased. In 1938 the system reverted to ½ S, a.d. 100%, resulting in a substantial increase in yield. A slight decline has to be recorded in 1939, but this may be attributed to the bad year. Both on Millakande and Nivitigalakele small increases occurred in 1939. (HC. 28 is in a favoured position on Millakande, though it should be pointed out that the general level of yield there is low).

The principal defect of the clone is its liability to Brown Bast. Test tapping was commenced on Stennes in August 1931, and by January 1936 six out of 26 trees had developed the disease. No further cases were recorded until November 1939 when two more trees succumbed and had to be taken out of tapping. At Nivitigalakele two cases have occurred out of ten trees ; no cases have yet been reported from Millakande.

Although the ½ S, 3d. 67% tapping system is not suited to the clone it may be that a different mild system such as 1/3 S, a.d. 67% will give better results. A small scale tapping experiment utilizing the block of 25 trees at Nivitigalakele is to be commenced in 1940.

Spiral fluting at the base of the stem is a common defect of the clone, though the incidence and degree of development appear to vary in different localities. Although it makes the trees look ugly it rarely interferes seriously with tapping and the renewed panels appear to be flattening out.

Growth is exceptionally vigorous and bark renewal is strong. The latex is very yellow.

The high yield of the clone in all the localities where it has been tested justifies consideration of its inclusion in a planting programme, but since it is difficult to know what percentage of Brown Bast would occur under commercial tapping conditions, at present it can only be approved for use on a small scale.

Hillcroft 55.—The previously reported anomalous yield behaviour of individual trees of this clone on Stennes is undoubtedly due to mixing. It was stated last year that two of the trees in test tapping there had been found to be rogues, while in 1939 it was discovered that seed of several different types was produced by trees of the same block, though not in test tapping. This indication that the block is thoroughly mixed is supported by the yield of a further 35 trees, test tapped from November 1938 to February 1939, which varied from 2 to 121 grams per tapping !

The true buddings on Stennes still continue to yield very well, but the comparative failure of a block of undoubtedly correct material on Millakande is puzzling. The results from a block of this clone which will be taken into tapping at Nivitigalakele in 1941 will be awaited with interest.

Wagga 6278.—This clone continues to maintain its excellent promise in test at Nivitigalakele. The yield per tree per tapping fluctuated very considerably from month to month during 1939, yet in spite of this variation the seven trees gave the very satisfactory average of 51 grams per tapping, or 13.7 lbs. per tree for the whole year. This represents an increase of 0.6 lbs. over the 1938 figure, although the year was a bad one and the number of tappings less.

A further 10 trees of this clone, tapped in connection with a bark consumption experiment, gave 8.7 lb. per tree for 117 tappings in the second year of tapping (9 years old).

If the yield shows a satisfactory increase in 1940 and no important defects develop it will be possible to consider recommending this clone for large scale commercial planting under conditions similar to those at Nivitigalakele. For the present we approve of the use of the clone for small scale planting only.

TABLE I

YIELD IN GMS./TAPPING FOR EACH YEAR OF AGE, Etc.

Clone	Where tapped	No. of trees tapped in 1939	Average Age in years on 1.7.39	Average Girth ins. at 3 ft. on 1.9.39	Average yield in grams dry rubber per tree per tapping for years: 1932	1933	1934	1935	1936	1937	1938	1939	No. of tappings in 1939	Yield per tree in lbs. in 1939	Tapping System
Millakande 3/2 ...	Nivitigalakele...	10	9	38·4			11	21	30	43	42	60	119	15·6	½S.a.d. 100%
Do. ...	Millakande ...	10	10	31·3				14	23	28	32	36	127	10·0	do.
Millakande 1/1 ...	Nivitigalakele ..	10	9	28·6					16	26	23	25	120	6·6	do.
Do. ...	Millakande ...	10	10	25·0				15	22	25	28	28	127	8·0	do.
Millakande 4/3 ...	do. ...	10	10	29·5				11	16	26	24	20	127	5·5	do.
Hillcroft 28 ...	Stennes ...	12	13	42·7	42	47	60	69	65*	57*	73	67	137	20·3	do.
Do. ...	do. ...	10	13	39·2				74	59*	56*	69	64	137	19·3	do.
Do. ...	Nivitigalakele...	8	8½	36·1					16	26	40	43	121	11·5	do.
Do. ...	Millakande ...	10	9	34·8					23	31	41	44	127	12·2	do.
Hillcroft 55 ...	Stennes ...	7	13	43·0		56§	63§	65	79	70	79†	68	95	14·3	½S.3d. 67%
Do. ...	Millakande ...	10	9	27·0				10	18	18	24	22	127	6·0	½S.a.d. 100%
Wagga 6278 ...	Nivitigalakele...	7	9	33·3					8	29	48	51	122	13·7	do.
Millakande 1/3 ...	do. ...	6	8	31·2					3	11	20	32	114	7·9	do.
Dalkeith 5315 ...	do. ...	7	9	31·1					5	13	22	29	123	7·8	do.
Diyaberiyakande 1	do. ...	9	9	28·3					6	14	29	29	123	7·7	do.
Beau Sejour 3 ...	do. ...	9	9	31·2					14	16	29	29	119	7·5	do.
Illabuluwa 37 ...	do. ...	10	9	30·3					7	12	22	28	121	7·4	do.
Heneratgoda 24...	do. ...	10	9	27·2					5	11	22	23	121	6·2	do.
Bandarapola 8 ...	do. ...	9	8½	28·8					8	13	18	24	114	6·0	do.
Alpitakande 18775	do. ...	8	8	27·8					3	9	17	23	115	5·9	do.
Bandarapola 21 ...	do. ...	9	8	29·3					6	9	17	23	116	5·8	do.
Madola 18 ...	do. ...	9	9	31·1					5	12	22	21	123	5·7	do.
St. George 40 ...	do. ...	10	9	31·5					2	6	18	21	121	5·7	do.
Dalkeith 1 ...	do. ...	10	9	31·8					6	13	20	21	121	5·7	do.
Kiriella 11 ...	do. ...	8	9	33·4					8	14	24	21	121	5·6	do.
Seedling Control	do. ...	10	11	34·7					10	15	24	24	121	6·5	do.

* Tapped on ½S.3d. 67% †Tapped on ½S.a.d. 100% March to September. § Tapped on ½S.a.d. 100%

TABLE II

CALCULATED YIELD IN LBS. PER TREE PER YEAR

Clone	Where tapped	No. of trees tapped in 1939	Calculated yield in lb. per tree for 130 tappings on ½ S,a.d. at ages of (to nearest half-year) :																	
			4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	13
Millakande 3/2 ...	Nivitigalakele...	10	3·0	—	6·0	—	8·7	—	12·2	—	11·7	—	17·0								
Do. ...	Millakande ...	10	—	—	—	—	3·9	—	6·5	—	7·9	—	9·1		10·4						
Millakande 1/1 ...	Nivitigalakele...	10	—	—	—	—	4·5	—	7·4	—	6·4	—	7·2								
Do. ...	Millakande ...	10	—	—	—	—	4·3	—	6·3	—	7·1	—	8·1		8·1						
Millakande 4/3 ...	do. ...	10	—	—	—	—	3·2	—	4·5	—	7·4	—	6·8		5·7						
Hillcroft 28 ...	Stennes ...	12	—	—	—	—	12·0	—	13·4	—	17·4	—	19·8		15·2		14·0		20·4		19·2
Do. ...	do. ...	10	—	—	—	—	—	—	—	—	—	—	12·7		13·4		13·6		19·2		18·2
Do. ...	Nivitigalakele...	8	—	—	—	4·5	—	7·5	—	12·0	—	12·3									
Do. ...	Millakande ...	10	—	—	—	—	6·6	—	8·9	—	11·6	—	12·5								
Hillcroft 55 ...	Stennes ...	7	—	—	—	—	—	—	16·1	—	18·1	—	15·2		19·0		16·8		20·8		16·4
Do. ...	Millakande ...	10	—	—	2·6	—	5·1	—	5·1	—	6·8	—	6·2								
Wagga 6278 ...	Nivitigalakele...	7	—	—	—	—	2·4	—	8·2	—	13·7	—	14·7								
Millakande 1/3 ...	do. ...	6	—	—	—	—	0·7	—	3·0	—	5·6	—	9·2								
Dalkeith 5315 ...	do. ...	7	—	—	—	—	1·3	—	3·8	—	6·3	—	8·2								
Diyaberiyakande 1	do. ...	9	—	—	—	—	1·8	—	3·9	—	8·2	—	8·2								
Beau Sejour 3 ...	do. ...	9	—	—	—	—	3·9	—	4·5	—	8·4	—	8·2								
Illabuluwa 37 ...	do. ...	10	—	—	—	—	1·5	—	3·2	—	6·3	—	7·9								
Heneratgoda 24...	do. ...	10	—	—	—	—	1·4	—	3·2	—	6·3	—	6·7								
Bandarapola 8 ...	do. ...	9	—	—	—	2·3	—	3·8	—	5·2	—	6·8									
Alpitakande 18775	do. ...	8	—	—	0·9	—	2·6	—	4·9	—	6·6	—									
Bandarapola 21 ...	do. ...	9	—	—	1·7	—	2·6	—	4·9	—	6·5	—									
Madola 18 ...	do. ...	9	—	—	—	—	1·1	—	3·2	—	6·4	—	6·0								
St. George 40 ...	do. ...	10	—	—	—	—	0·6	—	1·7	—	5·2	—	6·1								
Dalkeith 1 ...	do. ...	10	—	—	—	—	1·7	—	3·8	—	5·8	—	6·1								
Kiriella 11 ...	do. ...	8	—	—	—	—	2·3	—	3·9	—	6·9	—	6·0								
Seedling Control	do. ...	10	—	—	—	—	—	—	—	—	2·9	—	4·3		7·0		7·0				

TABLE III

COMPARISON OF CEYLON CLONES WITH IMPORTED CLONES

Clone	Where tapped	No. of trees tapped in 1939	Year budded or planted	Average girth ins. at 3 ft.	Caculated yield in lbs. per tree for 130 tappings at ages of:												
					5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11
Millakande 1/1 ...	Nivitigalakele ...	10	1930	28·6	—	—	4·5	—	7·4	—	6·4	—	7·2				
Hillcroft 28 ...	do. ...	8	1930	36·1	—	4·5	—	7·5	—	12·0	—	12·3					
Wagga 6278 ...	do. ...	7	1930	33·3	—	—	2·4	—	8·2	—	13·7	—	14·7				
Beau Sejour 3 ...	do. ...	9	1930	31·2	—	—	3·9	—	4·5	—	8·4	—	8·2				
Diyaberiyakande 1	do. ...	9	1930	28·3	—	—	1·8	—	3·9	—	8·2	—	8·2				
Prang Besar 23 ...	do. ...	9	1930	30·0	—	1·3	—	2·7	—	7·8	—	8·2					
Prang Besar 25 ...	do. ...	8	1930	29·7	—	—	1·4	—	3·9	—	6·1	—	6·0				
Millakande 3/2 ...	Millakande ...	10	1929	31·3	—	—	3·9	—	6·5	—	7·9	—	9·0		10·4		
Millakande 1/1 ...	do. ...	10	1929	25·0	—	—	4·3	—	6·3	—	7·1	—	8·0		8·1		
Millakande 4/3 ...	do. ...	10	1929	29·5	—	—	3·2	—	4·5	—	7·4	—	6·8		5·7		
Hillcroft 28 ...	do. ...	10	1930	34·8	—	—	6·6	—	8·9	—	11·6	—	12·5				
Hillcroft 55 ...	do. ...	10	1930	27·0	2·6	—	5·1	—	5·1	—	6·9	—	6·2				
Tjirandji 1 ...	do. ...	10	1930	32·3	3·3	—	6·1	—	5·7*	—	7·8*	—	8·2*				
Bodjong Datar 2 ...	do. ...	10	1930	24·8	—	—	3·0	—	4·6	—	3·6	—	5·1				
Bodjong Datar 5 ...	do. ...	10	1930	25·5	—	—	3·3	—	4·5	—	4·1	—	4·5				
Bodjong Datar 10	do. ...	10	1930	24·0	—	—	3·1	—	4·7	—	4·3	—	4·7				
Wawulugala 320†	Wawulugala ...	45	1932	20·2	—	—	—	—	4·7								
Milleniya 191† ...	do. ...	30	1932	23·1	—	—	—	—	3·9								
Tjirandji 1† ...	do. ...	120	1932	21·3	—	—	—	—	6·1								
Tjirandji 16† ...	do. ...	25	1932	21·7	—	—	—	—	7·1								
Glenshiel 1† ...	do. ...	110	1932	20·0	—	—	—	—	4·9*								
Bodjong Datar 5†	do. ...	30	1932	22·6	—	—	—	—	5·8								

* Tapped on 1/3 S,a.d. 67%

† Tapped from November 1938 to October 1939.

TABLE IV

YIELDS IN 1939 CALCULATED ON A BASIS OF 130 TAPPINGS CLONES IN TEST-TAPPING AT NIVITIGALAKELE

Clone	No. of trees	Age in years on 1.7.39	Girth at 3 ft. in ins. on 1.9.39	Year of tapping	Yield per tree in lbs.
		Field 3C			
Millakande 3/2 ...	10	9	38·4	6th	17·0
Millakande 1/1 ...	10	9	28·6	4th	7·2
Kosgalla 6 ...	9	9	31·7	4th	5·6
		Field 3A			
Wagga 6278	7	9	33·3	4th	14·7
Hillcroft 28	8	8½	36·1	4th	12·5
Dalkeith 5315... ...	7	9	31·1	4th	8·2
Prang Besar 23 ...	9	9	30·0	4th	8·2
Beau Sejour 3... ...	9	9	31·2	4th	8·2
Diyaberiyakande 1 ...	9	9	28·3	4th	8·2
Illabuluwa 37... ...	10	9	30·3	4th	7·9
Seedling Control ...	10	11	34·7	4th	7·0
Heneratgoda 24 ...	10	9	27·2	4th	6·7
St. George 40... ...	10	9	31·5	4th	6·1
Dalkeith 1	10	9	31·8	4th	6·1
Madola 18	9	9	31·1	4th	6·0
Kiriella 11	8	9	33·4	4th	6·0
Prang Besar 25 ...	8	9	29·7	4th	6·0
Kiriella 12	8	9	31·3	4th	5·1
Dalkeith 19935 ...	10	9	32·2	4th	5·1
Elston 2213/16 ...	10	8	28·5	3rd	5·4
Malaboda 1	10	9	26·3	3rd	4·8
Culloden 4	8	9	28·6	3rd	4·3
Frocester 120... ...	7	8½	30·0	3rd	3·4
Nakiadeniya 3 ...	10	9	28·1	3rd	3·1
Diyaberiyakande 4 ...	9	9	29·4	3rd	3·1
Frocester 168... ...	10	8½	28·1	3rd	2·5
Madola 22	10	9	27·6	2nd	4·2
Hunasgiriya 1391 ...	10	8½	23·2	2nd	3·9
Markville 1	10	7½	28·5	2nd	3·4
Dalkeith 3513... ...	7	9	27·6	2nd	3·1
Warriapolla 76 ...	13	8	27·3	2nd	2·9
Nakiadeniya 1 ...	10	8	26·7	2nd	2·8
Nakiadeniya 4 ...	10	8½	25·8	2nd	2·4
Elston 2239/12 ...	9	8	25·0	2nd	1·9
Warriapolla 57 ...	6	9	25·1	2nd	1·7
Warriapolla 24 ...	10	9	25·2	2nd	1·4
Pilmoor A. 44	10	9	22·5	1st	5·2
Warriapolla 25 ...	10	8	22·8	1st	1·6

TABLE IV—(Contd.)

Clone	No. of trees	Age in years on 1.7.39	Girth at 3 ft. in ins. on 1.9.39	Year of tapping	Yield per tree in lbs.
		Fields 4B and C			
Millakande 1/3 ...	6	8	31·2	4th	9·2
Bandarapola 8 ...	9	8½	28·8	4th	6·8
Alpitakande 18775 ...	8	8	27·8	4th	6·6
Bandarapola 21 ...	9	8	29·3	4th	6·5
Eriagastenne 1 ...	10	8	29·0	4th	4·6
Tempo 15	8	8	26·5	3rd	4·2
Guava Hill 51 ...	10	8	28·4	3rd	3·8
Illabuluwa 147 ...	8	8	30·0	3rd	3·1
Panagula 34/5... ...	10	8	29·0	3rd	2·8
Illabuluwa 108 ...	10	8	28·6	3rd	2·2
Talgaskande 1/5 ...	10	8	25·8	2nd	4·6
Tempo 6	10	8	27·4	2nd	3·6
Alpitakande 843 ...	10	8	24·4	2nd	3·3
Humbaswalana 7/1 ...	9	8	28·7	2nd	2·9
Millakande 13/2 ...	10	7	26·4	2nd	2·2
Guava Hill 47 ...	10	8	25·0	2nd	2·1
Eriagastenne 2 ...	10	8	25·4	2nd	2·0
Guava Hill 50 ...	10	8	25·2	2nd	1·9
Bandarapola 1 ...	10	8	21·5	1st	3·1
Troy 6/11	10	8	21·8	1st	2·2
		Field 4A			
Seedling Control ...	23	11	33·3	1st	6·0
Prang Besar 186 ...	21	7½	24·0	1st	4·4
Coodoogalla 45 ...	19	7-7½	23·2	1st	4·2
Marcot 52	18	7-7½	23·6	1st	3·9
Culloden 2	20	7½-8	23·5	1st	3·2
Kepitigalla 3	22	7-8	24·0	1st	3·1
Ambatenne 1	17	7½	23·8	1st	2·8
St. George 60... ...	22	6-8	24·3	1st	2·6
Ambatenne 2	22	7½	24·1	1st	2·5
Gikiyanakande 4 ...	19	6½-7½	23·7	1st	2·2
Gikiyanakande 1 ...	22	6½-7½	23·5	1st	2·1
Warriapolla 22 ...	11	7-8	19·5	1st	2·0
Shaliacary 23	18	7	20·7	1st	2·0
St. George 2843 ...	17	8	22·7	1st	1·8
Hapugastenne 33 ...	20	8	23·5	1st	1·8
Gikiyanakande 2 ...	19	6½-7	21·3	1st	1·7
Millakande 11/2 ...	21	7	23·0	1st	1·7
Clara 4	9	7	20·0	1st	1·2
Alpitakande 18910 ...	16	7-7½	20·8	1st	0·9
Kepitigalla 7	4	8	19·7	1st	0·7

TABLE V

YIELDS IN 1939 CALCULATED ON A BASIS OF 130 TAPPINGS. CLONES IN SEMI-COMMERCIAL TAPPING AT NIVITIGALAKELE

Clone	Number of trees	Age in years	Yield per tree in lbs.
Millakande 3/2	66	8-9	10·9
Govinna 771	81	10-12	7·9
Lavant 28	75	10-12	7·4
Kobowella 41	73	9-10½	6·9
1926 Clearing Seedling Control ...	22	13	6·4
Beau Sejour 5	18	9-10½	6·3
Cuilcagh 4	104	10-12	6·0
Mirishena 11	40	9-10½	6·0
Glendon A4	82	9-10½	5·8
Govinna 1836	90	10-12	5·7
Mirishena 2	33	9-10½	5·7
Madola 110	49	9-10½	5·5
Eladuwa 4	96	9-10½	5·4
Eladuwa 1	156	9-10½	5·3
Cuilcagh 3	70	10-12	5·2
Palmgarden 4849	87	9-10½	5·2
Palmgarden 3183	27	9-10½	5·1
Millakande 10/2...	85	9-10½	5·0
Heneratgoda 2	94	10-12	4·8
Kobowella 42	98	9-10½	4·8
St. George 45	106	10-12	4·8
Eladuwa 5	86	10-12	4·4
Yogama 21Y	119	9-10½	4·1
Cuilcagh 5	94	10-12	4·0
Mirishena 3	110	9-10½	4·0
Frocester 56	73	9-10½	3·6
Yogama 8Y	46	9-10½	3·6*
Kosgalla 6	52	9	3·5
Lochnagar 1/15	82	10-12	3·5
Yogama IH	82	9-10½	3·0
Madola 15	28	9	2·8
Talagalla 2	71	9-10½	2·7
Eladuwa 3	73	9-10½	2·3

* The yield of Yogama 8Y in 1938 was 3·2 lbs., not 7·3 lbs. as stated in Table IV. of last year's report.

TABLE VI

MEASUREMENTS OF BARK RENEWAL AT NIVITIGALAKELE

Clone	Age in years	No. of trees	Mean girth in ins. at 3 ft.	Thickness of virgin bark	Thickness of renewed bark in millimetres and as a percentage of virgin bark thickness									
					1 year		2 years		3 years		4 years		6 years	
Millakande 3/2 ...	9½	14	35·5	7·5	4·6	61%	5·5	73%	5·8	77%	6·8	91%	7·4*	94%
Wagga 6278 ...	9½	7	33·3	8·2	4·8	59%	5·9	72%	6·7	82%	6·7	82%	—	—
Hillcroft 28 ...	9	9	36·9	7·9	5·2	66%	6·3	80%	6·6	84%	6·8	86%	—	—

* Based on 7 trees only ; all in test tapping ; average girth 39 inches.

FIELD EXPERIMENTS ON DARTONFIELD ESTATE—XI

MANURING EXPERIMENT WITH MATURE RUBBER (1939)

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and
C. A. de SILVA, *Assistant Botanist*

THIS paper summarises the yield records and growth measurements for the third year of a manurial experiment on Dartonfield Estate. The scope and design of the experiment and the statistical methods employed were described in the Quarterly Circulars, Vol. 13, Parts 2 and 3, 1936 and Vol. 15, Part 1, 1938 and are very briefly referred to below.

Treatments

The fertiliser treatments are :—

N, NP, NK, NPK and O (no manure). Manures were applied in December, 1936, December, 1937 and March, 1939. The change from a December to a March application was made on the assumption that if response to manure varies with time of application the greatest effect is likely to be obtained just after refoliation when root activity may be expected to be at its greatest. The manures were applied on a tree basis at the rate $N = P_2O_5 = K_2O = 0.4$ lbs. per tree.

The treatment will in future be further modified to a biennial application at double the rate given above in order to conform with general estate practice.

A comparison has also been made of two methods of applying the manure, broadcasting and forking, the cover where it occurs being left undisturbed.

Results

Table I gives the yields in kilograms per plot of 20 trees. The actual yields for the preliminary year 1936 have been included, but

for 1937, 1938 and 1939 the values refer to adjusted yields obtained by means of a regression on the 1936 yields. To obtain the approximate values for pounds per acre each figure should be multiplied by 11.

TABLE I

Mean Yields in Kilograms Dry Rubber per Plot of 20 Trees

Treatment	Actual Yields	Adjusted Yields		
	1936	1937	1938	1939
N	53·4	49·8 (111)	56·9 (114)	44·5 (112)
NP	52·3	47·5 (106)	52·9 (106)	41·5 (104)
NK	55·5	49·1 (110)	56·5 (113)	44·1 (111)
NPK	56·5	49·6 (111)	59·3 (119)	46·6 (117)
O	47·1	44·8 (100)	50·0 (100)	39·7 (100)
Mean	53·0	48·2	55·1	43·3
Standard Error ..		1·2	1·8	Not significant
Significant Difference (P. = ·05)		3·5	5·3	

(The figures in brackets give the adjusted yields as percentages of the unmanured plots).

It will be seen that the mean for 1939 is the lowest since the start of the experiment. This may largely be ascribed to the decrease in the number of tappings brought about by unfavourable weather conditions.

The experimental results for 1939 just fail to pass the conventional 20 : 1 test for statistical significance, but the trend of the responses to manures is apparently the same as in previous years. The NPK mixture appears to have given the best result and the NP mixture the poorest, apart from the unmanured plots.

The results for the year under review rather strengthen the contention mentioned in the 1939 report of this experiment that the small responses to manuring obtained so far should be treated with reserve.

Comment on the economic aspect of manuring rubber of this age will be withheld until further results have been obtained.

The average dry rubber content for the different manurial treatments is given in Table II.

TABLE II

Average Dry Rubber Content for 1939-40

Treatment	Percentage Dry Rubber
N	40·4
NP	39·5
NK	40·8
NPK	40·6
Control	39·4
Mean	40·1

The results are not statistically significant, but there is an indication that when phosphate alone is added to a nitrogenous manure the dry rubber content of the latex is lowered, an effect that has been obtained elsewhere.

This may in part account for the apparent difference in yield of dry rubber between the N and NP plots of this experiment, which is indicated in Table I above.

Method of Applying the Manure.—The figures for the comparison between broadcasting and forking are given in Table III.

TABLE III

Mean Yields in Kilograms of Dry Rubber per Plot of 20 Trees

Treatments	Adjusted Yields		
	1937	1938	1939
Manure broadcast	48·5	55·1	43·4
Manure forked in	47·8	55·1	43·2
Mean	48·2	55·1	43·3

The results to date show no significant difference in yield between the two methods of application.

Girth Increment.—The girth of every tree was measured at a height of 4 ft. from the ground. The mean figures for the different

treatments in the years 1937, 1938, 1939 and 1940 and the total increments over the period are given in Table IV.

TABLE IV

Girth Measurements in Inches

Treatments	1937	1938	1939	1940	Increment 1937-1940
N	35·76	36·32	36·53	36·72	0·96
NP..	37·32	37·95	38·13	38·30	0·98
NK	39·12	39·81	39·97	40·07	0·95
NPK	37·10	37·74	37·97	38·11	1·01
O	33·78	34·33	34·54	34·69	0·91
Mean	36·63	37·23	37·43	37·58	0·95

The treatment effects are not significant. Since the beginning of the experimental manuring in March, 1937, the trees have shown very little increase in girth, an average of only 0.3 in. per year.

Bark Renewal.—The results of measurements taken in January, 1938, 1939 and 1940 are presented in Table V.

TABLE V

Thickness of Renewed Bark in Millimetres

Treatments	1938	1939	1940	Increase 1938-40
N	4·8	5·3	6·0	1·2
NP	4·7	5·6	6·1	1·4
NK	4·8	5·4	6·0	1·2
NPK	4·8	5·6	6·3	1·5
O	4·9	5·5	6·1	1·2
Mean	4·8	5·5	6·1	1·3

On a statistical examination the results are found to be non-significant.

The general response to manuring as shown by increase in bark thickness can only be regarded as doubtful, but there are indications that phosphate may be of some importance.

SUMMARY

1. An experiment on Dartonfield Estate to determine the manurial requirements of mature Rubber is briefly described.

2. The results for the first three years (1937, 1938 and 1939) after the first application of fertilisers are given in terms of yield, girth increment and bark renewal.

3. When compensation is made for the initial differences shown by the uniformity trial of 1936 the manured plots in 1939 are seen to have given better yields than the unmanured, but the responses to manuring are not statistically significant.

4. The indication reported last year that the addition of phosphate without potash to a nitrogenous manure depresses yield is again noted in this year's figures.

5. A slight apparent depressing effect of phosphate on dry rubber content is seen in the 1939 results.

6. Very poor response to manuring has been shown by girth increment figures since the start of the experiment in 1937.

TIME OF TAPPING AND THE LARGE TASK*

A. H. HEALEY

IN wet weather, when tapping starts late, there is a considerable loss of crop, but there is also a constant loss every day, wet or fine, when the tapper is given a large task. Under control, with severely restricted output, such loss is immaterial, and it is then advisable to give a large task and cheapen the cost of tapping. When, however, releases reach 80 per cent. all estates which have replanted 20 per cent. of their area, or which have difficulty in reaching their assessment, have to harvest their maximum crop.

It therefore becomes necessary to obtain a measure of the losses, with a large task, from those trees tapped last in the round. The following test was tried for this purpose.

"Time of Tapping" Test

The test was over 1 tapping block of 180 trees, divided into 10 groups, A, B, C, D, etc., of 18 trees each. Trees were 17 years old, spaced 30 ft. by 15 ft. and tapped on the Double-Four system.

Trees were numbered consecutively 1 to 180 along the row, group A starting at No. 1 tree, group B at No. 19 tree, and so on.

On the first tapping day, the tapper started at group A, and went on to B, C, D, etc. On the second tapping day he started at group B and followed on; and on the third day at group C, and so on.

Yields of each group were registered in fluid ozs. of latex, the yield of the first tapped group on any day being entered in the

* The Rubber Research Board welcomes papers on subjects of general interest from outside contributors but does not accept any responsibilities for the views expressed therein.

first column of the table, the second tapped group in the second column, and so on, the trial being completed on the tenth tapping day.

Thus the first column shows all the 180 trees as tapped first, the second column shows them all as tapped second, and so on. Scrap was not included.

As groups with several high yielders overweighted the figures, the test was repeated, with the grouping moved on six trees. Thus group A started at No. 7 tree, group B at No. 25, and group C at No. 43, and so on.

A third trial was made, with the grouping moved on a further six trees, group A starting at tree No. 13, group B at No. 31, group C at No. 49, and so on.

FIRST TRIAL

Group Tapped										Total for Day (Fluid ozs.)
1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	
51	45	58	54	38	31	38	32	32	45	424
34	39	41	33	28	28	23	24	36	28	314
44	50	39	39	39	26	32	48	40	32	389
59	45	41	44	41	40	57	54	43	46	470
48	48	51	42	46	61	48	48	56	46	494
49	56	52	46	64	56	52	60	54	47	536
67	62	55	75	63	62	74	64	39	33	594
46	42	64	53	51	60	53	45	39	44	497
38	66	55	46	56	49	41	36	38	35	460
64	55	52	63	52	45	38	42	35	32	478
500	508	508	495	478	458	456	453	412	388	4,656

TOTAL OF THE THREE TRIALS

Group Tapped										Total for Day (Fluid ozs.)
1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	
500	508	508	495	478	458	456	453	412	388	4,656
426	438	435	410	394	391	379	350	347	335	3,905
388	365	365	325	309	312	298	299	270	278	3,209
1,314	1,311	1,308	1,230	1,181	1,161	1,133	1,102	1,029	1,001	11,770

GROUP PERCENTAGES

100	99·8	99·5	93·6	89·9	88·3	86·2	83·9	78·3	76·2

CUMULATIVE PERCENTAGES FOR 1, 2, 3, ETC., GROUPS

100	99·9	99·7	98·2	96·5	95·2	93·9	92·6	91·1	89·6

Comments

Up to about the fiftieth tree losses are insignificant, but the losses in the last three groups are severe. These, for lack of a better expression, can be called " sun effects." It is presumed that in districts with only one monsoon, and with the consequent long period of droughty weather, great care is necessary in arriving at the economic task. If, in addition to a single monsoon, there are hot drying winds, as in parts of Matale, a small task would appear to be of the first importance.

In the test, the 180 trees is large for the Double-Four system, but the land was flat and without boulders. Effects would be the same for any single cut system, or with a smaller task, or on steep land, the single criterion being the time the tapper takes to finish his task. If he is late in reaching the factory, a reduction of the task is indicated.

Sun Effects

The figures in the test were only registered on days when there was no interference with tapping, and they therefore only apply to fine weather. Wet weather effects are considered separately.

The ten groups give 89.6 per cent. of potential crop. The first seven groups give 93.9 per cent. The rise is 4.3 on 89.6, *i.e.* 4.8 per cent. With the inclusion of scrap, this latter figure is reduced to about 4.2 per cent. of total crop. That is for a 30 per cent. reduction in the task.

This 4.2 per cent. increase is much less than was anticipated. If the task were reduced there would be more careful work. But greater care takes longer time, and it is not known how much one effect would off-set the other. In the test it was ensured that every tree was tapped. In day to day work over a whole estate, there are some lazy or unambitious tappers, who will leave out trees when given a large task. Then, too, the test was carried out during the wet months, whilst "sun effects" would be increased during the drier months.

As a hazard, it may be taken that under ordinary conditions, on fine weather days, the reduction of the task would give at least 6 *per cent. increase in total crop.*

Actual Crop Figures

The following are the crop figures for an estate in Kalutara, which gives a task of 180 trees on the Double-Four system :—

213 fine weather days	gave	244,699 lbs.
78 late tapping days	,,	68,281 ,,
16 part wash-out days	,,	6,236 ,,
16 total wash-out days	,,	Nil ,,
42 days—rest and holidays	,,	Nil ,,
365 days	gave	319,216 lbs.

The daily intakes averaged 1,149, 875, and 390 lbs. respectively, and a late tapping day gave 76 per cent. of the crop obtained on a fine day.

The test showed that on a fine day the overall intake was 89.6 per cent. of the "potential" crop, had all the trees been tapped very early in the morning. Seventy-six per cent. of this 89.6 per cent. is 68 per cent. Thus with a large task the intake on a late day is only 68 *per cent. of "potential" crop.*

What Happens in Wet Weather

Referring to the individual group figures in the test, we see that, if the first eight periods are lost, only the 78.3 per cent. and

the 76.2 per cent. are known, the other groups have to be guessed at thus :—

$$
\left.\begin{array}{l} 78\cdot3 \\ 76\cdot2 \end{array}\right\} \text{as in Time of Tapping Test}
$$

$$
\left.\begin{array}{l} 74 \\ 72 \\ 70 \\ 68 \\ 65 \\ 62 \\ 59 \\ 56 \end{array}\right\} \text{estimated}
$$

$$
10 \,|\, \underline{680\cdot5}
$$

68·05% = Overall percentage for late tapping days as required by the actual crop figures above.

If the task be reduced by three groups, then the percentages for seven groups would be :—

78·3, 76·2, 74, 72, 70, 68, 65.
and the overall percentage then would be 72%.
The rise, therefore, would be from 68% to 72%.

This equals an increase of 6% for the lighter task on wet days.

Partial Wash-out Effects

When a partial washout occurs after tapping has started, the calculation is simple. Crop is directly proportional to the number of tappers scampering for their latex.

A Measure of Total Effects

Taking the year's crop figures for the Kalutara estate, as given above, it is now possible to state a figure of the total effects of reducing the task by 30 per cent.

6% increase on 244,699 lbs.	=	14,681 lbs.
6% increase on 68,281 lbs.	=	4,096 ,,
Proportional increase, 7 to 10 on, 6,236 lbs. ..	=	2,672 ,,
Total increase	=	21,449 ,,

On the crop of 319,216 lbs., this is an *increase of* 6·7%

The figure is smaller than usually anticipated, but would appear to be on the safe side. In the test, the task was a large one, so that all the trees were tapped hurriedly. It is unfortunate that the opposite trends of more careful tapping and of the longer time that that takes, cannot be accurately gauged. Does extra care greatly outweigh the time taken, or are the trees left out by the lazy tapper, and those not tapped on late start days the decisive factor?

WAR-TIME COAGULANTS

A NOTE ON PROPRIETARY SUBSTITUTES

M. W. PHILPOTT, *Chemist*

The Present Position

IN the last issue of this journal (R.R.S. Quarterly Circular, 1939. 16. 118) reference was made to the local shortage of acetic and formic acids following the outbreak of war, and advice was given on the use of alternatives. Since December, 1939, when that article appeared the situation has altered considerably and the severe shortage which for a few months caused much anxiety among Ceylon rubber producers has been made good by the arrival of substantial shipments of acetic and formic acids, chiefly from the United Kingdom, Canada and Switzerland. The following table shows that by December, 1939, the import figures were already up to their normal pre-war level and that in January and February, 1940, they were in excess of this amount by 30 per cent. and 115 per cent. respectively.

Month	Acetic Acid cwts.	Formic Acid cwts.	Approx. Relative Coagulating Power
Pre-war average*	210	246	100
December, 1939	398	181	109
January, 1940..	521	196	130
February, 1940	1,136	190	215

* For period January, 1936 to June, 1939, inclusive.

As, moreover, there is virtually no consumption of coagulants in Ceylon during the month of February it is reasonable to believe that there was at least two months reserve of stocks in the Island by the time estates recommenced tapping after the resting period.

Proprietary Coagulants

From the earliest days of the shortage, producers were strongly advised not to use substitutes of unknown composition without first obtaining a report from the Rubber Research Scheme. In spite of this warning a number of materials appeared on the market under trade names and were used extensively and without discrimination, particularly by the smaller producers who, as a class, are at once the most affected by any shortage of normal coagulants and the least capable of judging the merits of proprietary alternatives.

Composition of Coagulants.—For the most part those who were responsible for these fancy products displayed a remarkable lack of originality. From this charge we may perhaps exclude the inventor who justified the sale of dilute sulphuric acid at seven times its value on the grounds that it had been subjected to "a secondary process of select hybridization." But in the choice of materials the producers of war-time coagulants appear to have drawn liberally on the ideas of their predecessors of 1914-1918. Among the preparations made according to closely guarded "secret formulas" several were found to be nothing more than alum, the use of which was prohibited in the Federated Malay States by the Rubber Dealers' Enactment of 1919, on account of its harmful action on rubber.

Most of the proprietary coagulants which were received for testing contained sulphuric acid as their main ingredient. Subsidiary substances were in many cases added to give the acid a pungent smell more or less reminiscent of the smell of acetic or formic acid. To this end some of the coagulants were actually mixed with a small proportion of acetic acid; others contained sodium bisulphite, common salt, vinegar or fruit juices. Second in popularity to sulphuric acid was alum, a substance that appeals to the user on account of its low cost and the satisfactory type of coagulation it produces. A few vegetable products, chiefly vinegar or vinegar reinforced with sulphuric acid, were also placed on the market.

On the whole the samples which were examined were satisfactorily free from traces of the dangerous metals copper and manganese. A notorious exception was the coagulant whose main constituent was copper sulphate; this product was swiftly suppressed

and the purveyor was informed with some emphasis that he could not possibly have chosen a worse material for a coagulant. Many of the samples were strongly contaminated with iron as a result, probably, of mixing the acids in iron vessels.

Choice of Substitutes.—In advising rubber producers on the suitability of these coagulants for emergency use the view was generally taken, paradoxical though it may seem, that a material which causes bubbles, discolouration or some other defect in the appearance of the rubber sheet is preferable to one which is capable of producing what the market would judge to be first grade rubber. All substitutes for acetic and formic acids are more or less objectionable and hence the most insidious materials are those which are not automatically revealed by the off-grade appearance of the rubber.

The statement that all substitutes are objectionable may seem rather sweeping, but it is based on two important considerations. The first is that out of the hundreds of substances which are capable of converting latex into a workable coagulum, acetic and formic acids are the only known materials which fulfil certain essential secondary requirements. These acids are industrial products of a high standard of purity and uniformity: they are commercially available, under normal conditions, in adequate quantities at a reasonable cost: and they do not adversely affect the quality of rubber when they are used under the somewhat haphazard manufacturing conditions that are still widespread in the East. It is true that certain other coagulants, notably sulphuric acid, can be used to produce standard rubber if they are used with proper care and control and in the full knowledge of their limitations. But clearly this measure of control cannot be applied if the coagulants are used in the form of proprietary products of which the strength and purity are unknown.

The second consideration is that the rubber market, rightly or wrongly, views any change from normal methods of manufacture with extreme suspicion. The extensive use in Ceylon of any substitute, however innocuous, would therefore involve the risk of creating an undesirable market prejudice against Ceylon rubber.

Cost of Coagulants.—Soon after the outbreak of war steps were taken by Government to check profiteering in acetic and formic acids by fixing maximum prices. During the period of control the retail price of acetic acid was fixed at Rs. 34 per carboy of four gallons.

It is interesting to compare the prices at which substitute coagulants were marketed during the same period. From the selling price and composition of six of the most popular proprietary coagulants the following table has been drawn up to show the approximate cost of the essential ingredients and their relative cost on the basis of equivalent coagulating power. The last column gives roughly the cost of coagulating 8,000 lbs. of rubber which is approximately the out-turn of a carboy of acetic acid. All the coagulants referred to in the table, except the first two, were being sold under trade names. Coagulant No. II was labelled "99 per cent. Acetic Acid."

No.	Essential Constituents	Selling Price per carboy	Approx. value of constituents	Cost of coagulating 8,000 lbs. of rubber
I	Sulphuric acid	.. Rs. 25·00	Rs. 3·50	Rs. 60·00
II	Do.	.. ,, 40·00	,, 5·00	,, 40·00
III	Do.	.. ,, 36·00	,, 3·50	,, 60·00
IV	Sulphuric acid and alum	.. ,, 36·00	,, 4·00	,, 44·00
V	Sulphuric acid and sugar	.. ,, 30·00	,, 4·00	,, 37·00
VI	Rice vinegar	.. ,, 15·00	—	,, 187·00

This table shows clearly the necessity for scrutinising carefully the prices of proprietary substitutes in relation to their coagulating power.

Conclusion

It is hoped that this note may serve to underline the Research Scheme's advice to treat all proprietary coagulants with suspicion, and in an emergency to use only those alternatives whose composition, intrinsic value and technical suitability are well established.

Now that acetic and formic acid imports are increasing it is earnestly hoped that rubber producers will revert to normal methods of coagulation with as little delay as possible. Though most of the acid recently landed in the Island has been allocated to fulfil outstanding orders further large shipments are expected and there should soon be fair quantities available for purchase in the local market.

REPLANTING IN AREAS INFESTED BY ROOT DISEASE*

PRELIMINARY RESULTS OBTAINED FROM AN EXPERIMENT ON LOW LAND ON SUMATRA'S EAST COAST

Introduction

THE development of reliable high yielding planting material and the provisions of the International Restriction Scheme have combined to induce more and more estates to initiate replanting programmes.

While most planters agree on the cultural methods that are desirable, there is little information generally available to indicate the practical value of the various operations. It is hoped, therefore, that the preliminary results reported in this paper may be of assistance to those who have to assess the relative importance of certain simple treatments.

Description of the Experiment

(*a*) *Area and Old Stand.*—The experiment occupies about 244 acres, situated on Serbangan Estate of the Hollandsch-Amerikaansche Plantage Mij., on a brownish-white clay soil in which occur several large and irregular patches of almost pure sand. Except that the soil is perhaps more fertile than the average, it is fairly representative of large areas of the flat coastal clay soils of the East Coast of Sumatra. The land was formerly under tobacco and was planted with rubber in 1911. Prior to the period of low rubber prices in 1931-1934, the soil was kept clean-weeded, but during this period a cover of *Pueraria Javanica* was established. As is commonly the case on such soils, the cover required no special manuring, and no particular difficulty was experienced with it.

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* Paper by J. F. H. Cronshey and C. Barclay of the Plantation Research Department of the United States Rubber Plantations, reproduced from the Archief voor Rubbercultuur XXIII, 3, 1939, by kind permission.

In 1924, half of the area was manured with ammonium sulphate and half with sodium nitrate; the whole area was manured with ammonium sulphate at a rate of 4 lb. per tree in 1926, 1928, 1930, and 1935.

The old stand in the area was in general well grown, the trees being of good size and having an excellent leaf canopy. The chief fault was that it was exceedingly patchy, being full of large spaces, caused mainly by root disease, round which the trees were dying rapidly. At the time of its removal, the stand, which had been planted at 121 trees per acre (quincunx 30 feet × 24 feet) and thinned to about 80 trees per acre, averaged under 60 trees per acre, and root-collar inspection showed that 15 per cent. of the remaining trees were attacked by root rot, many of them being nearly dead from disease. It may be remarked that a bad root-disease area was deliberately chosen in order to obtain as much information as possible on these diseases.

(*b*) *Experimental Layout and Treatments.*—The experiment was initiated in 1936, when the area was divided into twenty-four long narrow plots, each about 2,400 feet long and 180-200 feet wide, or about 10 acres in extent. Long strip-plots of this type were chosen to minimize the differences between plots. The plots were grouped into three blocks of eight plots each, the assignment being made so that the differences between the plots within the blocks were as small as possible, for both the mean girth of the trees and the stand per acre.

The eight plots in each block were assigned at random to the eight treatment series listed below and the land was cleared and prepared for planting in each plot according to its series :—

1. Trees felled, by cutting off about a foot above the ground; clean-weeded.
2. Trees felled; *Pueraria* cover planted.
3. Trees felled; soil changkolled[1] to a depth of 15-18 inches with removal of roots but not of stumps; clean-weeded.
4. Trees felled; soil changkolled; *Pueraria* cover planted.

[1] In this paper a verb "to changkol" has been employed to describe the process of digging as normally carried out by the natives with a "changkol" or short-handled grub-hoe.

5. As 1, but trees removed with stump-pullers, so that the root-collars and parts of the tap roots and large side roots were pulled out.
6. As 2, but trees removed with stump-pullers.
7. As 3, but trees removed with stump-pullers.
8. As 4, but trees removed with stump-pullers.

After lining at 300 trees per acre (square planting 12 feet by 12 feet, super-imposed on the old planting so that theoretically no new tree would be less than six feet from an old stump), the planting places in the east or west half of each plot were treated by digging 2 feet by 2 feet by 2 feet holes and filling them with top soil free from roots ; this increased the number of treatments to sixteen, *i.e.* the eight enumerated above in the presence and absence of holing. Here again, the holing treatment was placed in narrow strips within the plots in order to increase the precision of the comparison of holing versus none, since it was thought that any effect of this treatment would probably be relatively small and would therefore require the maximum precision obtainable.

Planting was done in the autumn of 1936, with seedlings derived from seed from monoclone areas. Part of the experiment was planted with stumped seedlings, from nurseries made during the 1935 seed season, and part with basket seedlings, from the 1936 seed season. The planting was done by strips across the plots, so that the different plots contain roughly the same amounts of stumped and basket seedlings. After planting, supplying of early losses was continued until February, 1937, and a further supplying round was done in October, 1937. From the time of planting onwards, circles about six feet in diameter were kept clean-weeded round the young trees in plots planted with *Pueraria Javanica*.

Experimental Results

(*a*) *Growth Data.*—The diameters of trees in fifteen sample rows running across the plots were measured at six inches above ground level in October, 1937, and again in July, 1938, and the mean diameters by plots from these measurements were examined

by means of the analysis of variance to determine what differences were significant. Table I summarizes the results :—

TABLE I

Mean Diameters of Trees by Treatment Series

Treatment	Oct., 1937	July, 1938	Significance of Differences	
			October, 1937	July, 1938
Pueraria cover ..	3·43 cm	6·61 cm	99 : 1	999 : 1
Clean-weeding ..	3·78	7·56		
Soil changkolled ..	3·72	7·24	Between 9 : 1	Between 9 : 1
Soil not changkolled..	3·49	6·94	and 19 : 1	and 19 : 1
Holing..	3·70	7·18	999 : 1	19 : 1
No holing	3·51	7·00		
Stumps removed ..	3·62	7·08	—	—
Stumps left	3·59	7·10		
Mean	3·60	7·09		

Note.—The figures presented for the significance of the differences are odds that the differences found are actually caused by the treatments. It is usual to classify a result as significant if these odds are over 19 : 1, highly significant if they are over 99 : 1, and very highly significant if they are over 999 : 1.

The effects in this table are quite straight forward and require little comment. With regard to the effect of changkolling, it may be remarked that the difference is in the expected direction, *i.e.*, the changkolling of the soil has resulted in a greater girth, and the odds against the occurrence of such a difference in the absence of a real effect are about 30 : 1. The effect of holing apparently occurred entirely in the early months, the present difference of 0.18 cm. comparing with a difference of 0.19 in October, 1937. The effect of changkolling was also relatively greater at first, whereas the effect of the cover has increased considerably.

As the measurements given are diameters, the girths are approximately three times as large, so that by July, 1938, *Pueraria* had depressed the girths by about 3 cm, changkolling probably increased them by about 1 cm. and holing increased them by about 0.6 cm.

(*b*) *Tree Losses*.—A complete tree map of the young stand has been made, and on this map are recorded all the deaths which occur in the stand. For this purpose, inspections are conducted every month. Where a tree has died from one of the rhizomorph-producing root-diseases (*Fomes* or *Ganoderma*) the cause is recorded as "*Fomes*," but where no rhizomorphs can be found the tree is recorded as having died from unknown causes. The tree losses, from planting to August, 1938, are shown in Tables II and III, Table II showing the trees where the cause was undetermined and Table III those where root disease was found. The cause of the latter was almost invariably the white root-disease, usually referred to the species *Fomes lignosus*=*Rigidoporus microporus*. This species was predominant even in the old stand on this flat soil, with the result that its normal predominance in young stands has been accentuated.

TABLE II

Numbers of Trees Lost Through Unknown Causes

Treatment	Trees felled; no chang-kolling	Trees felled; soil chang-kolled	Stump-pulled; no chang-kolling	Stump-pulled; soil chang-kolled	Total
Clean-weeded; no plant holes	471	340	356	307	1474
Clean-weeded; plant holes dug	427	258	316	223	1224
Pueraria cover; no plant holes	379	290	303	253	1225
Pueraria cover; plant holes dug	218	260	254	261	993
Total	1495	1148	1229	1044	4916

Notes.—Table II includes any trees which may have died from "*Fomes*" prior to February, 1937, when records were initiated, and also any trees where it was not possible to be certain that "*Fomes*" was the cause of death. Consequently some "*Fomes*" losses are probably included.

A single figure in the table represents the losses from about 15 acres.

Included in the table are all recorded losses, regardless of whether they were later supplied or not. Supplies which subsequently died are also included.

TABLE III

Numbers of Trees Lost Through *Fomes* and Allied Diseases

Treatment	Trees felled; no chang-kolling	Trees felled; soil chang-kolled	Stump-pulled; no chang-kolling	Stump-pulled; soil chang-kolled	Total
Clean-weeded ; no plant holes	729	611	917	524	2781
Clean-weeded ; plant holes dug	671	518	712	400	2301
Pueraria cover ; no plant holes	406	421	321	194	1342
Pueraria cover ; plant holes dug	293	298	168	111	870
Total	2099	1848	2118	1229	7294

Note.—See notes to Table II.

Apart from the one series, stump-pulling and clean-weeding with no changkolling or holing, where the losses in Table III appear to be rather high, the differences in Table II show the same trends as those in Table III. Whereas, however, the differences in the latter table are very marked, those in the former are relatively slight and it is, therefore, a natural inference that the differences between the losses from " unknown causes " are at least partly due to the inclusion among them of trees which really died from *Fomes* or allied causes. At the same time, it is quite likely that part of the differences, particularly between holing and no holing, and changkolling and no changkolling, is due to a reduction in the deaths due to miscellaneous causes, as a result of the better soil treatment.

The main differences between the series are, however, to be found in the "*Fomes*" losses. The effect of the *Pueraria* is the most striking, the cover having reduced the losses in all comparisons, by about 60 per cent. on an average. Holing has also reduced the losses in all series, though its effect is not so large, and it is interesting to record that, as might be expected, the reduction was

much more marked in the early part of the period. This is shown in Table IV :—

TABLE IV

"*Fomes*" Losses in Holed and Unholed Planting Places

	Losses during 11-15 months (a) 1936-1937	Losses during 8 months 1938
No holing	1353	2770
Holing	739	2432

Note.—(a) As inspections were started in February, 1937, all losses from February to December, 1937, and a part only of the losses in the period October, 1936 to January, 1937, are included in the data.

As is shown by the column totals in Table III, stump-pulling and changkolling are closely interrelated, neither being of much value in the absence of the other. Collectively, however, they have reduced the losses by nearly a half, and it is noticeable that the effect has been larger when other favourable treatments, holing and the establishment of a cover, were also done. In general, the combined effect of the favourable treatments is better than the sum of their single effects, the percentage reduction being considered as the correct measure of efficiency.

Discussion

As may be seen from the results presented in this paper, normal and simple treatments such as are commonly employed in practice do have a considerable effect on the growth and health of young replanted stands. The striking effects of the leguminous cover confirm previous opinions based on other experiments and on general observation ; the effect of holing has not been the subject of much comment, but is much as might be anticipated ; and the interrelated effects of stump-pulling and changkolling are also reasonable. There is no reason why stump-pulling should have any effect on growth, and it is clearly to be anticipated that the removal of both stumps and roots would be necessary to give any great effect on disease losses. With regard to the depth of changkolling done, it is perhaps pertinent to remark that, while the tap roots of some trees extend to some depth, the root systems of the

trees on these soils are generally shallow and the vast majority of the roots are removed by chankolling to 15-18 inches.

The present data concern only the first two years in the life of the young stand and it would, of course, be premature to draw any final conclusions from them. Nevertheless, the differences between the treatments are already very striking. The worst stands, those with no treatment or with stump-pulling or changkolling only, are already full of large spaces which are rapidly increasing in size, whereas the best series are on the whole very satisfactory. Moreover, the rate of loss is increasing rapidly, as is indicated in Table IV, and this increase is particularly marked in the series with little treatment. Probably the young stand has now reached a stage when the roots of the young trees have spread sufficiently to make good contact with the old stumps and roots, and in this case the losses will continue to be heavy, if not heavier, in the next few years. It is anticipated that it will be necessary to conduct intensive root-disease treatment in the area during the next year.

Summary and Conclusions

The effects found to date in this experiment are as follows :—

(1) *Growth*—

(*a*) Clean-weeded series have consistently grown better than those with a *Pueraria* cover, the present advantage for the weeding being about 3 cm. in the mean girth.

(*b*) Changkolling series have grown somewhat better than those with no changkolling, the present advantage being about 1 cm. in the mean girth. The difference is still increasing, but not rapidly.

(*c*) Holing increased the growth of the trees initially, but appears to be having no further effect. The present advantage is about 0.6 cm. in the mean girth.

(2) *Root-disease Losses*—

(*a*) *Pueraria* has markedly reduced the losses in all series, the losses in *Pueraria* plots being only about two-fifths of those in clean-weeded plots.

(*b*) Stump-pulling and changkolling have had little effect singly, but when applied together (clean-clearing) have reduced the losses by a little under half.

(*c*) Holing has reduced the losses by about a quarter, its effect being largest in the first year.

(*d*) Collectively, stump-pulling, changkolling, *Pueraria* and holing have reduced the losses through *Fomes* and similar diseases to about a seventh of their value in the absence of any of these treatments. The losses in the worst series are about 55 trees per acre, or 18 per cent., while those in the best series, with all the treatments, are 7.4 trees per acre, or 2.5 per cent.

As can be seen, changkolling (if accompanied by stump-pulling) and holing have conferred a double advantage on the stand in increasing growth and decreasing losses. It must be remembered, however, that these results only hold up to an age of under two years, and it is possible that the holing may merely have delayed the losses. The losses in the plots which were stump-pulled and changkolled indicate that the amount of changkolling was insufficient, and it would probably have paid to changkol more thoroughly in known root-disease complexes. It may be added that the effect of these treatments on growth alone does not seem sufficient to justify their cost in areas where root disease is unimportant.

The effect of the cover crop in reducing both growth and disease losses is very marked, and it seems likely that the best treatment would be to establish a cover and to weed either large circles round the trees or strips along the rows of trees.

Acknowledgments

The authors wish to express their appreciation to Mr. J. Grantham for his guidance and assistance in designing the experiment.

MEETING

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the fiftieth meeting of the Rubber Research Board held at Dartonfield Estate, Agalawatta, at 10 a.m. on Thursday, January 18th, 1940.

Present: Mr. E. Rodrigo, C.C.S. (in the chair), Mr. C. H. Collins, C.C.S. (Deputy Financial Secretary), Mr. I. L. Cameron, Mr. L. B. de Mel, J.P., U.P.M., Mr. G. E. de Silva, M.S.C., Mr. T. C. A. de Soysa, Mr. W. P. H. Dias, J.P., Mr. L. P. Gapp, Mr. F. H. Griffith, M.S.C., Mr. R. C. Kannangara, M.S.C., Mr. J. C. Kelly, Mr. F. A. Obeyesekere, Mr. N. D. S. Silva, O.B.E., J.P., and Mr. E. W. Whitelaw.

Mr. T. E. H. O'Brien, Director, was present by invitation.

1. Minutes

Draft minutes of the meeting held on October 12th, 1939, which had been circulated to members were confirmed and signed by the Chairman.

2. Board

The Chairman reported the following changes in the membership of the Board since the last meeting :—

(*a*) Mr. F. H. Griffith, M.S.C., had resumed membership from 15th November, 1939, on his return from leave relieving Mr. L. E. Russell who had acted for him.

(*b*) Mr. F. H. Griffith, M.S.C., had been renominated as a representative of the Planters' Association of Ceylon for a further period of three years from 15th November, 1939.

(*c*) Mr. F. A. Obeyesekere had been renominated to represent the smallholders for a further period of three years from 26th November, 1939.

3. Conference of Directors of Rubber Research Organisations in the East

Decided that the Director should attend the Conference of Directors of Rubber Research organisations in the East, to be held at the headquarters of the Rubber Research Institute of Malaya on February 26th, 1940. The Director was authorised to spend approximately two weeks in Malaya and to pay short visits to Java and Sumatra.

4. Stabilisation of Income from Cess Collections

Consideration was given to letters from the Ceylon Estates Proprietary Association; Low-Country Products Association; Planters' Association of Ceylon and Rubber Growers' Association, expressing the views of the associations on the proposal to stabilise the Board's income from cess collections. The Chairman was asked to reply to points raised by one of the associations.

5. Accounts

(*a*) *Statement of Receipts and Payments of the Board for the quarter ended 30th September*, 1939,—was adopted.

(*b*) *Dartonfield and Nivitigalakele accounts for August and September*, 1939—were tabled.

(*c*) *Ceylon Government* $3\frac{1}{4}$% *Loan*, 1949/51.—Reported that a sum of Rs. 75,000 had been invested in the Ceylon Government $3\frac{1}{4}$% Loan, 1949/51.

(*d*) *Fixed Deposits*.—Reported that fixed deposits totalling Rs. 85,000 had been renewed for a period of 12 months.

(*e*) *Supplementary Votes*.—Supplementary votes were approved as follows :—

Headquarters Votes	Rs. 450
Estate Votes	Rs. 1,240

6. Staff

Re-engagement of Director.—The Chairman reported that the Director's service contract was due to terminate on 19th December, 1940. After consideration it was decided to offer re-engagement for a period of three years and eight months in accordance with the terms of service previously approved for officers recruited from abroad. Leave of absence out of the Island was also approved for a period of eight months from April 1st. The Director accepted re-engagement on the terms offered. The Board unanimously passed a special vote of appreciation of the useful work done by Mr. O'Brien during his present tour of service.

7. Experimental Committee

Recommendations made at a meeting held on November 28th, 1939, were considered.

Visiting Agent's Visits.—The recommendation was approved that the Visiting Agent should inspect the Board's estates twice annually in future instead of three times, and that the fee per visit be increased by Rs. 50.

Establishment of Seed Gardens.—The desirability of establishing isolated seed gardens planted with clones which are being used experimentally for breeding trials was endorsed and the Chairman agreed to place concrete proposals before the Board at a later date.

Clone Museum in Mid-country Area.—Decided that application be made to Government for the lease of 25-30 acres of land in a mid-country area for the purpose of studying the resistance to Oidium of proved and promising clones.

Land at Nivitigalakele.—Decided that application be made to Government for the lease of an additional 100 acres of land near to Nivitigalakele to provide for future field trials.

8. London Advisory Committee for Rubber Research (Ceylon and Malaya)

Minutes of meetings of the London Advisory Committee for Rubber Research (Ceylon and Malaya) and the Technical Sub-Committee held on April 28th and September 29th, 1939, were tabled.

9. Progress Reports

Progress reports of the Technical Officers for the quarter ended September 30th, 1939, were considered and adopted.

10. Research Programmes for 1940

Research Programmes for 1940 were considered and adopted. It was noted that the programmes would be followed subject to any modifications which might become necessary owing to war conditions.

11. Publications

The Planting Memorandum entitled "Emergency Rubber Coagulants" which had been issued to the press in English and Sinhalese as a communication from the Research Scheme was tabled.

Research Laboratories,
Dartonfield, Agalawatta,
5th February, 1940.

London Advisory Committee for Rubber Research (Ceylon and Malaya).

Member nominated by the Colonial Advisory Council of Agriculture and Animal Health:

Sir Frank Stockdale, K.C.M.G., C.B.E.

Member nominated by the Government of Ceylon:

Dr. W. Youngman, D.Sc., Ph.D.

Member nominated by the Governments in British Malaya:

Mr. J. Lornie, C.M.G.

Members representing Malayan Planting interests—nominated by the Rubber Growers' Association:

Mr. P. J. Burgess (Chairman).
Mr. J. L. Milne.
Mr. Eric Macfadyen.

Members representing Ceylon Planting interests—nominated by the Rubber Growers' Association:

Sir Herbert Wright.
Mr. G. H. Masefield.
Mr. George Brown.

Member representing Manufacturing interests:

Lieutenant-Colonel J. Sealy-Clarke.

Ex-Officio Members:

Sir H. A. F. Lindsay, K.C.I.E., C.B.E., Director of the Imperial Institute.
Professor V. H. Blackman, Director of the Botanical Laboratories, Imperial College of Science and Technology.
Dr. S. P. Wiltshire, Director of the Imperial Mycological Institute.
Sir John Russell, O.B.E., Director of the Rothamsted Experimental Station.

Secretary:

Mr. J. A. Nelson, B.Sc.

The Technical Sub-Committee consists of members of the Advisory Committee with the following co-opted Members:

Mr. G. Martin (Superintendent of Rubber Investigations).
Mr. G. E. Coombs.
Mr. G. G. Balazs.
Mr. B. D. Porritt.
Mr. H. N. Ridley
Mr. W. C. Smith
Dr. H. P. Stevens
Dr. D. F. Twiss
Prof. R. G. H. Clements

STAFF.

Mr. G. Martin, B.Sc., A.I.C., F.I.R.I.
Mr. H. C. Baker, M.Sc., A.I.C., A.I.R.I.

RUBBER RESEARCH SCHEME (CEYLON)

LIST OF PUBLICATIONS FOR SALE

Bulletins No. 1-20. Bound volume, **Rs. 5.00.** **Later Bulletins Re. 1.00** per copy.

No. 1.	The Effect of Tapping on the Movements of Plant-Food in *Hevea Braziliensis.*	
No. 2	The Effect of Tapping on the Movements of Plant-Food in *Hevea Braziliensis.*	
No. 3.	Seasonal Variations in the Movements of Plant-Food in *Hevea Braziliensis,* Part I.	
No. 4.	The Physiological Effects of Various Tapping Systems, Part I.	
No. 5.	Progress Report on Vulcanization Tests.	
No. 6.	The Physiological Effects of Various Tapping Systems, Part II.	
No. 7.	The Physiological Effects of Various Tapping Systems, Part III.	
No. 8.	Seasonal Variations in the Movements of Plant-Food in *Hevea Braziliensis,* Part II.	
No. 9.	Vulcanization Tests.	
No. 10.	Vulcanization Tests.	
No. 11.	Variability in Rubber Manufacture.	
No. 12.	Progress Report of the Rubber Research Chemist.	
No. 13.	Vulcanization Tests.	
No. 14.	On the Variation in the Number of Latex Vessels present in *Hevea Braziliensis.*	
No. 15.	Vulcanization Tests.	
No. 16.	On the Natural Clotting of Rubber Latex	
No. 17.	Vulcanization Tests.	
No. 18.	Measurements of " Bark Renewal"	
No. 19.	Vulcanization Tests.	
No. 20.	Vulcanization Tests.	
No. 21.	Vulcanization Tests.	1919
No. 22.	Vulcanization Tests.	1919
No. 23.	Vulcanization Tests.	1920
No. 24	Vulcanization Tests.	1920
No. 25.	Investigations on Samples of Plantation Para Rubber from Ceylon.	1921
No. 26.	Results of Trials of Ceylon Plantation Rubber for the Manufacture of Ebonite	1921
No. 27.	Investigation on Samples of Plantation Para Rubber from Ceylon.	1921
No. 28.	Investigations on Samples of Plantation Para Rubber from Ceylon.	1922
No. 29.	Summary of the Principal Results Obtained from Investigations into the Properties of Ceylon Plantation Rubber in Relation to its Method of Preparation.	1922
No. 30.	The Penetration of Disinfectant on the Tapping Cut of *Hevea Braziliensis.*	1922
No. 31.	On the Occurrence "of Rust" on Sheet Rubber.	1923
No. 32.	On the Preservation of Latex.	1924
No. 33.	Investigations on Samples of Plantation Para Rubber from Ceylon.	1924
No. 34.	Investigations on Samples of Plantation Para Rubber from Ceylon.	1924
No. 35.	Investigations on Samples of Plantation Para Rubber from Ceylon.	1924
No. 36.	Investigations on Samples of Plantation Para Rubber from Ceylon.	1924
No. 37.	Investigations on Samples of Plantation Para Rubber from Ceylon.	1924
No. 38.	Investigations on Samples of Plantation Para Rubber from Ceylon.	1925
No. 39.	Do. (Final Report Series 1)	1925
No. 40.	Do. Series II	1926
No. 41.	Do. First Interim Report on Artificial Ageing Tests.	1926
No. 42.	On the Smoking of Sheet Rubber in Relation to Mould Prevention.	1926
No. 43.	The Inter-Relationship of Yield and the Various Vegetative Characters in *Hevea Braziliensis* (out of print).	1926
No. 44.	The Construction of Smokehouses for Small Rubber Estates (out of date).	1926
No. 45.	The Efficiency of Disinfectants and Fungicides.	1927
No. 46.	The Control of Bark Rot by Disinfectants.	1927
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